



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Thomas W. Stone  
Application Serial No.: 10/700,828  
Filed: November 4, 2003  
For: WAVELENGTH SELECTIVE SWITCHING AND/OR ROUTING SYSTEM

Examiner: Agustin Bello  
Group Art Unit: 2633  
Confirm. No.: 6251

To: Commissioner of Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION UNDER 37 CFR 1.131**

Sir:

I, Orlando Lopez, declare that:

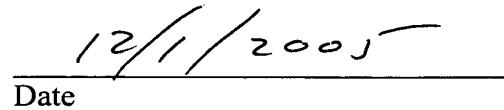
1. I am the patent agent/attorney who prepared the above-referenced patent application.
2. Prior to May 29, 2003, the assignee, Agilent Technologies, Inc., contacted the law firm of Perkins Smith & Cohen LLP and requested them to file a patent application on the combined Invention Disclosure Nos. 10020907 and 10020912 (copies attached with dates deleted).
3. At least three draft patent applications were generated by me for review and revision (comments) by the inventor, Thomas W. Stone, just prior to May 29, 2003 to November 4, 2003, at which date the application was filed in the U.S. Patent and Trademark Office.
4. Each draft patent application improved upon the prior draft until the inventor, Thomas W. Stone, approved the final draft for filing as a patent application.

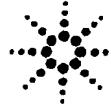
I even further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United

Application No. 10/700,828  
Attorney Docket No. 10020907-1  
Declaration Under 37 CFR 1.131

States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

  
Orlando Lopez

  
Date



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WRI

## INVENTION DISCLOSURE

PDNO

10020907 DATE RCVD

ATTORNEY GPJ

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## Descriptive Title of Invention:

Wavelength Selective Cross-Connect Based On Switchable Gratings

Name of Project: Pinot

Product Name or Number: N/A

Was a description of the invention published, or are you planning to publish? If so, the date(s) and publication(s):  
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Was a product including the invention announced, offered for sale, sold, or is such activity proposed? If so, the date(s) and location(s):  
N/A

Was the invention disclosed to anyone outside of AGILENT TECHNOLOGIES, or will such disclosure occur? If so, the date(s) and name(s):  
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Was the invention described in a lab book or other record? If so, please identify (lab book #, etc.)

Powerpoint presentation and lab books (TWS-1 and TWS-2)

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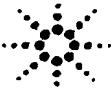
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- A. Prior solutions and their disadvantages (if available, attach copies of product literature, technical articles, patents, etc.).
- B. Problems solved by the invention.
- C. Advantages of the invention over what has been done before.
- D. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.)

Signature of Inventor(s): I (we) hereby submit this disclosure on this date: [REDACTED].

918323 Thomas W. Stone		895-0234	Pinot (Bethlehem, PA)
Employee No.	Name	Signature	Telnet Mailstop Entity & Lab Name
Employee No.	Name	Signature	Telnet Mailstop Entity & Lab Name
Employee No.	Name	Signature	Telnet Mailstop Entity & Lab Name
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**Signature of Witness(es): (Please try to obtain the signature of the person(s) to whom invention was first disclosed.)**

The invention was first explained to, and understood by, me (us) on this date: 1/23/01

Full Name Michelle M. Stone	Signature <i>Michelle M. Stone</i>	Date of Signature 1/23/01
Full Name Thomas A. Mitchell	Signature <i>Thomas C. Mitchell</i>	Date of Signature 1/23/01

**Inventor & Home Address Information: (If more than four inventors, include add'l. information on a copy of this form & attach to this document)**

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**A. PRIOR SOLUTIONS AND THEIR DISADVANTAGES**

Other wavelength selectable cross connects are typically slower, more expensive, exhibit higher insertion loss, lower crosstalk suppression, and in some cases may be inferior with respect to size, WDL, and PDL.

**B. PROBLEMS SOLVED BY THE INVENTION**

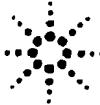
The wavelength selectable cross connects of this invention exhibit higher speed (tens or hundreds of microseconds), much lower insertion loss, higher crosstalk suppression (isolation), and may be more compact than other approaches. In addition, there is a potential for greatly reduced cost with this current device family. Wavelength selectable cross connects are important optical telecom devices.

**C. ADVANTAGES OF THE INVENTION OVER WHAT HAS BEEN DONE BEFORE**

The wavelength selectable cross connects of this invention exhibit higher speed (tens or hundreds of microseconds), much lower insertion loss, higher crosstalk suppression (isolation), and may be more compact than other approaches. In addition, there is a potential for greatly reduced cost with this current device family.

**D. DESCRIPTION OF THE CONSTRUCTION AND OPERATION OF THE INVENTION**

A canonical  $1 \times N$  wavelength selectable cross connect of the present invention is shown in Figure 1. Here the input is separated into its  $m$  spectral WDM component signals (longer wavelengths deviated through larger displacements) using a twin grating disperser in which the gratings are typically parallel and of the same spatial frequency. The resolved WDM channels are then passed through an array of  $m \times N$  switches as shown. This allows for each of the  $m$  input WDM channels to be independently routed to any of  $N$  output columns. The final grating pair combiner is identical to the input grating pair except that the final pair is wider (physically larger

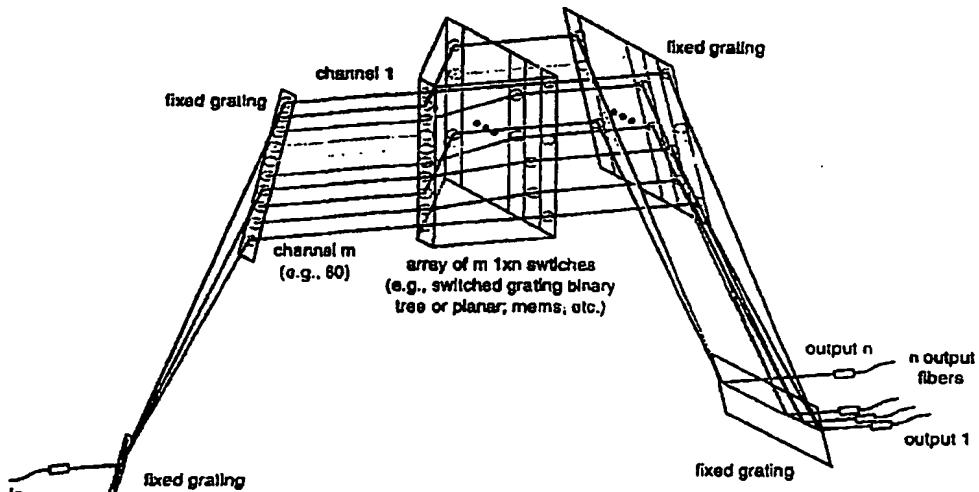


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gratings, but still just two gratings). This grating pair combines any wavelength channels present in a given column into an array of N multiplexed outputs as shown in Figure 1. In such a fashion, each of m wavelength signals in the input can be independently routed to any of N output ports or fibers.

## Pinot Wavelength Selectable 1xn Cross Connect (Generic Configuration)



Pinot OADM Prelim. Concepts 3

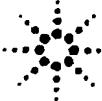
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Figure 1.

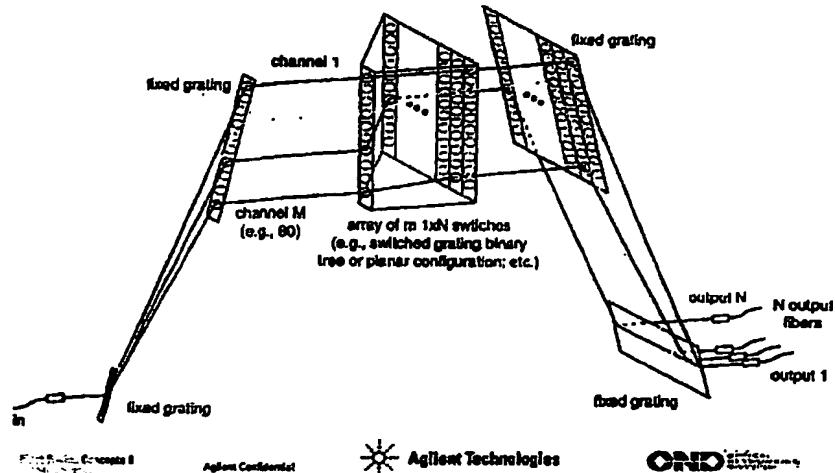
The less cluttered case of illustrating only 4 of the m channels being switched is shown in Figure 2.



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## Pinot Wavelength Selective 1xn Cross Connect (Generic Configuration)



Pinot Prox. Concepts II

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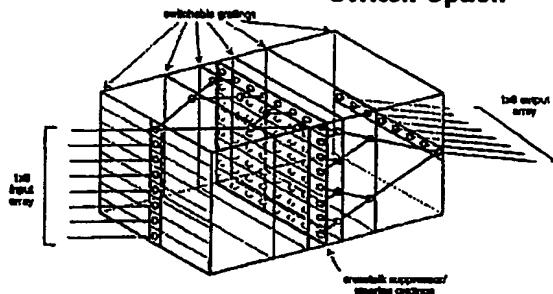
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Figure 2.

An ideal candidate for the array of  $m \times N$  switches for the present invention is the front half of the  $M \times N$  cross connect as described in existing Agilent patents and shown in Figure 3.

## Pinot Wavelength Selectable 1xN Cross Connect Switch Option



- Front half of 8x8 is array of 1xN Switches

Pinot Prox. Concepts II

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Figure 3.



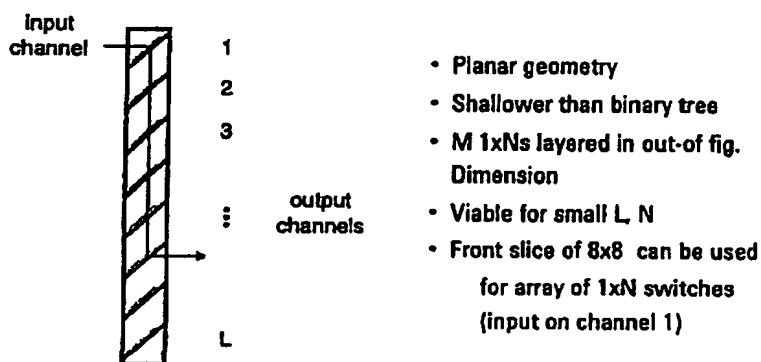
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This array of  $m$   $1 \times N$  switches has very low insertion loss and is compact for the typical dimensions of wavelength selective cross-connect likely to be used in telecom applications. Further it is relatively inexpensive since only a small number of stripe-pixellated gratings need be fabricated for the array (e.g., 3 gratings for an array of 80  $1 \times 8$  switches).

A more compact alternative for the array of  $m$   $1 \times N$  switches is shown in Figure 4. Here  $N$  switchable gratings are stripe pixellated (a cross section of 1 of  $m$  stripe pixel layers shown in Figure 4) and form the array of  $m$   $1 \times N$  switches. The details of this switch array follow from the planar crossbar invention previously disclosed. The transmission-grating version is shown, and an analogous switched holographic mirror version has the advantage of near zero WDL when fiber coupled and is also described in the planar crossbar invention.

### Pinot Wavelength Selectable $1 \times N$ Cross Connect Switch Option



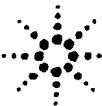
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Figure 4.



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provide for the general wavelength selective  $L \times N$  cross connect function. Accordingly any wavelength in any of the input fibers can be routed to any of the output fibers. Many different technologies can be used for the array of  $M L \times N$  switches. Such based on switchable gratings are desirable due to their low insertion loss and high speed. One such switch array is an array of planar cross connects as described in an earlier disclosure and shown in Figure 6. The switch of Figure 6 would be a single layer of a stack, shown in cross-section from above. This device as shown would be inserted in the configuration of Figure 5 and the resulting configuration would then be as shown but deviated through 90 degrees at the switch. The switchable mirror version of the planar crossbar would be preferable since there would be no residual angular or lateral dispersion from the switch. Similarly the transmission switch array of Figure 7 could be used, and would result in an offset. The advantage of the switch of Figure 7 is that it is wavelength compensated for angular dispersion even with transmission gratings, although there is residual lateral dispersion. The lateral dispersion of the switch array of Figure 7 is readily reduced by replacing the single large final compensation grating with the extension of the lower edge gratings to an  $L+1$  level, and using a mirror array to redirect the compensated beams downward again.

### Pinot Wavelength Selectable 1xN Cross Connect Switch Option

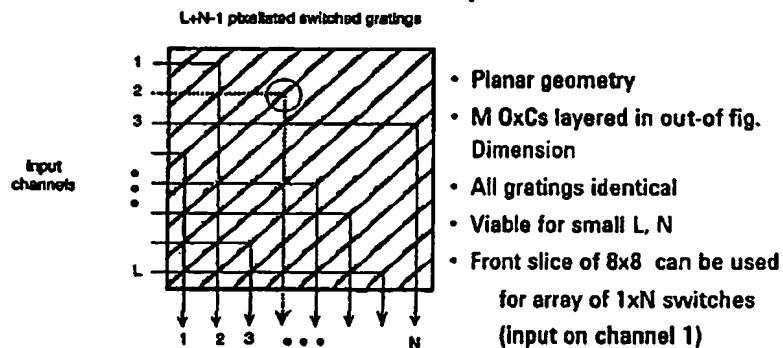
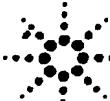


Figure 6.



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918323 Thomas W. Stone		895-0234	Pinot (Bethlehem, PA)
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918323 Thomas W. Stone

895-0234

Pinot (Bethlehem, PA)

Employee No.	Name	Signature	Telnet	Mailstop	Entity & Lab Name
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Full Name	Signature	Date of Signature
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Full Name	Signature	Date of Signature
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**Inventor & Home Address Information:** (If more than four inventors, include add'l. information on a copy of this form & attach to this document)

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Inventor's Full Name
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#### A. PRIOR SOLUTIONS AND THEIR DISADVANTAGES

The disperser-combiner switched grating devices can require significant complexity to fit in a small product footprint. In addition, the WDL and other specs can be large without added system complexity.

#### B. PROBLEMS SOLVED BY THE INVENTION

The present invention can greatly reduce the size of switched grating based tunable filters, interleavers, band channelizers, and wavelength selectable cross connects. Further, there is potential for reducing the CD of these systems with the present invention.

#### C. ADVANTAGES OF THE INVENTION OVER WHAT HAS BEEN DONE BEFORE

The present invention can greatly reduce the size of switched grating based tunable filters, interleavers, band channelizers, and wavelength selectable cross connects. Part of the size reduction is due to the efficient manner in which the different wavelength channels are resolved, and the relatively uniform spacing that can result. Further, there is potential for reducing the CD of these systems with the present invention.

#### D. DESCRIPTION OF THE CONSTRUCTION AND OPERATION OF THE INVENTION

#### Canonical Disperser/ Combiner (CDC) (Segmentable Platform)

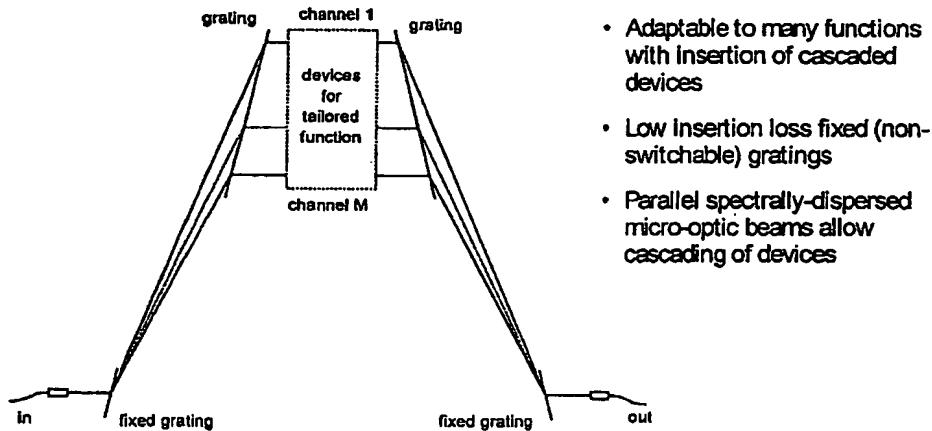


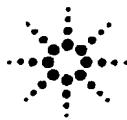
Figure 1.



In the canonical disperser/combiner shown in Figure 1, grating pairs are used first to disperse the WDM channels spatially, and then to recombine them. In the present invention, the grating pairs are each substituted with either single Array Waveguide Gratings (AWGs) or arrays of AWGs.

The switchable filter configuration in Figure 2 illustrates the present invention. In this tunable filter system, the pixellated switched grating (or cascade of switched gratings for enhanced contrast) are used as before, but in place of the grating pair dispersers and combiners, Array Waveguide Gratings (AWGs) are used. This has the advantage of potentially reducing the size and CD of the system, but this advantage comes at possibly an increased system cost (two AWGs); and the insertion loss, CD, WDL, etc. performance of the AWGs are introduced into the overall tunable filter performance. AWG cost and performance are rapidly improving, and so this is potentially an excellent trade-off in retaining the low insertion loss and high speed of switched grating systems and the compactness of the AWG dispersion.

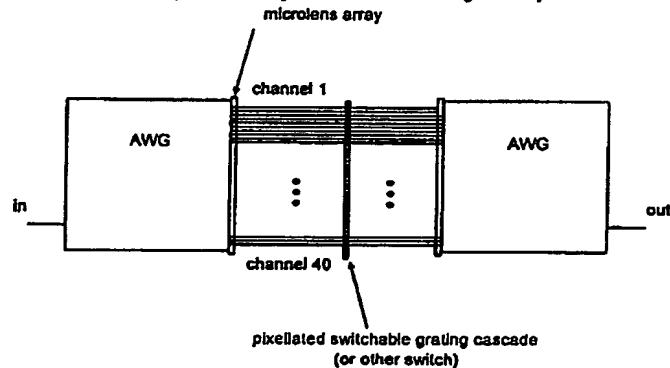
In the configuration of Figure 2, microlens arrays are used to transform the output of the AWGs into free space beams and back into waveguides again. Anamorphic optics may be used optionally to transform the waveguide outputs of the AWGs into circular beams.



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### Pinot Switchable Filter (Free-Space AWG Hybrid)



- Microlens array converts waveguide channels to free-space beams
- Possible Issues with insertion loss, filter shape, cost, CD, ...

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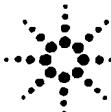
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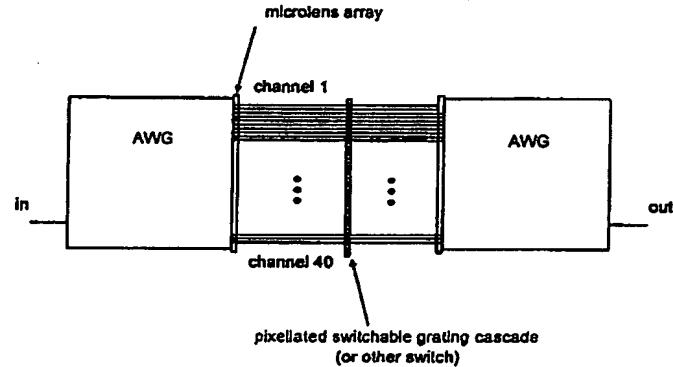
OND OPTICAL

Figure 2.

In the prior example, each grating pair was replaced with a single AWG. The  $1 \times N$  wavelength selectable cross connect of the accompanying disclosure can also benefit from the AWG substitution, and in this case the first grating pair in figure 3 is replaced by a single AWG as in Figure 2, and the second (wide) grating pair is replaced with an array of  $N$  AWGs.



### Pinot Switchable Filter (Free-Space AWG Hybrid)



- Microlens array converts waveguide channels to free-space beams
- Possible issues with insertion loss, filter shape, cost, OD, ...

Final Prelim Concepts 6  
13.2.00

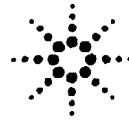
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Figure 2.

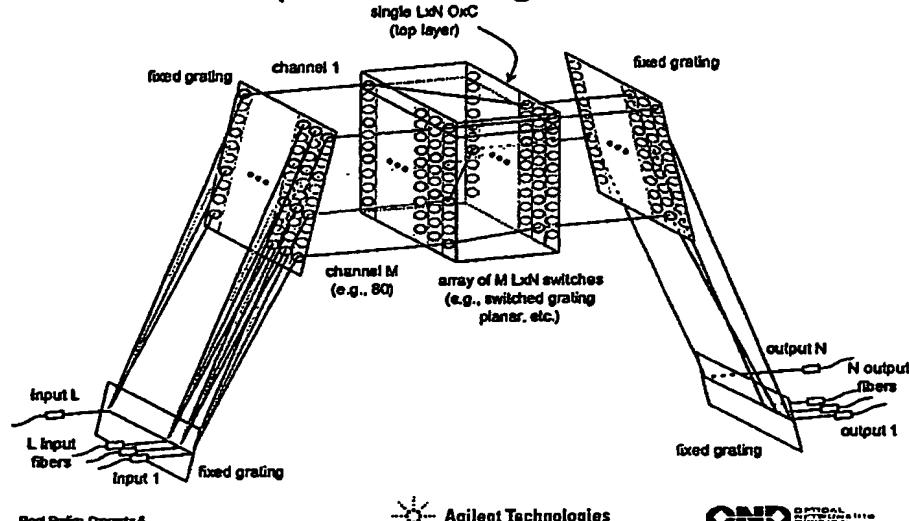
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## Pinot Wavelength Selective LxN Cross Connect (Generic Configuration)



Pinot Prelim Concepts 6  
134; v2.0.02

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Figure 4.